Mirror covered tunnel phototherapy increases the efficacy of phototherapy for neonatal jaundice

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Abstract

Objective:
Neonatal jaundice (NJ) is one of the most common cause of neonatal hospital admission. Phototherapy is the main therapy for hyperbilirubinemia of neonatal jaundice. The efficacy of phototherapy depends on the dose and wavelength of light used and the surface area exposed. We increased photons in mirror covered tunnel phototherapy (MCTP) by putting mirrors behind the lamps (mirror covering), without raising the temperature or risk of hyperthermia. This study evaluates the efficacy of this modification.

Methods:
In this randomized clinical trial study, during a 6-month period 30 neonates were treated for NJ; 60 neonates who had uncomplicated neonatal jaundice requiring only phototherapy were used as controls for the study by the convenience sampling method. The controls received single phototherapy by tunnel phototherapy while the study group underwent MCTP.In this set we put mirrors which were mercury coated 3 mm thick glass behind the bulbs of the set. Serum bilirubin was measured at admission, 24 hr and 48 hr after initiation of treatment, then daily and 24 hr after discharge. Independent sample t-test was used in SPSS version12 software for data analysis .

Results:
Mean duration of admission in the study group was significantly lower than controls (p= 0.027). Likewise the mean decrease in bilirubin level after 24 and 48 hr of phototherapy were significantly lower than controls (p= 0.005 and p= 0.036).

Conclusion:
Our results show that the use of mirrors behind the bulbs in tunnel phototherapy units can safely increase the efficacy of phototherapy.

Keywords:
Hyperbilirubinemia, Jaundice, Neonate, Phototherapy.

Introduction

Neonatal jaundice (NJ) is a serious problem worldwide. It is the most frequent cause of neonatal hospital admission. Phototherapy is the most common therapeutic intervention used for the treatment of hyperbilirubinemia of NJ. Although phototherapy has become a mainstay since its introduction in1958, a better understanding of the photobiology of bilirubin, characteristics of the phototherapy devices, the efficacy and safety considerations of phototherapy applications, and improvements in spectroradiometers and phototherapy devices are necessary for more predictable and improved clinical practices and outcomes(1).

It is perhaps the most common routine therapy

applied in the newborn population. How phototherapy came to be is a fascinating story, one with a nurse at its center (2).

A recent report from the American Academy of Pediatrics on neonatal hyperbilirubinemia confirms the efficacy of phototherapy to treat infants with jaundice (3).

Multiple phototherapy units are sometimes used to increase the light intensity and thus improve the efficacy of phototherapy (4).

However, light intensity and the area of light-exposed skin can also be increased through the use of reflecting surface (5).

Similarly, it has been proved that single phototherapy with low - cost reflecting curtains is more effective than single phototherapy alone; it may be a valuable alternative to double versus single phototherapy in term newborns with significant hyperbilirubinemia (6). The delivered irradiance determines the effectiveness of phototherapy.Irradiance is the light intensity, or number of photons, delivered per square centimeter of exposed body surface. The higher the irradiance, the faster the decline in serum bilirubin level (7).

If phototherapy systems produce sufficient irradiance over the area required it will ensure that the phototherapy is maximally effective, as this is likely to reduce the time that the neonate needs to undergo the treatment (8).

The efficacy of phototherapy depends on the dose and wavelength of light used and the surface area exposed (6).

Over the last 2 decades, there has been a constant endeavor to develop ways to increase the efficacy of phototherapy and at the same time reduce the side effects. By increasing the lamps, the dose of light increases but risks of hyperthermia and dehydration in neonates may increase. Therefore, there is a limitation on lamp quantity in each set. We modified a traditional set by putting mirrors behind the lamps (mirror covering), without raising the temperature or risk of hyperthermia. This study evaluates the efficacy of this modified set.

Methods

This was a randomized clinical trial study lasted six months. All babies admitted to the Phototherapy Ward of Imam Khomeini Hospital of Ardabil Medical Sciences University were studied. All had uncomplicated neonatal jaundice requiring only phototherapy. The need for phototherapy was determined using Nelson's guidelines for management of jaundice in healthy term newborns. Neonates who had serum bilirubin close to the exchange transfusion limit and other problems such as sepsis were excluded from the study. Altman`s Nomogram was used for calculating sample size. Sixty neonates (30 in each group) were treated. The babies included in the study were randomized either to receive single phototherapy(control group) by routine tunnel phototherapy device (Tosan Infant Phototherapy unit Model 022 I.R.IRAN*) or single phototherapy covered with mirrors (same set) at both sides of the unit. In this set we put mirrors which were mercury coated 3 mm thick glass behind the bulbs of the set. After randomizations to one of the groups, the infant remained in that group until phototherapy could be stopped or until the infant exited the study. We studied 30 neonates and 30 babies as controls. All units used in the study were serviced just before the study began and were maintained in optimal working condition for the duration of the study. The distance between the phototherapy unit and the baby was standardized at 45 cm. The primary outcome measure was the mean difference in serum bilirubin between baseline and after 24 hr and 48 hof phototherapy. Secondary outcome measures included the total duration of phototherapy. Decisions to stop phototherapy were made according to guidelines of Nelson. Serum bilirubin was measured at admission, 24 and 48 hr after initiation of treatment, then daily and 24 hr after discharge. The safety of both methods was assessed and compared by monitoring the body temperature, hydration status (monitored clinically and by weighing the baby), skin problems (such as rash or bronze baby syndrome) and gastrointestinal problems (such as loose stools or feeding intolerance). Statistical analysis of data were done using SPSS version 12 software.

The mean decrease in serum bilirubin and the mean duration of phototherapy in each group was analyzed by comparing the means with independent t-tests. The study was approved by the Research and Ethics Committee of the Ardabil University of Medical Sciences, and written parental consent was obtained.

Results

Mean body weight in both groups had no significant differences; the study group weighed 3125.5 g (449.7 SD) and control group weighed 3131.9 g (573.8 SD).

In the interventional group, 16 patients (53.3%) and in control group 30 patients (50%) were born by Cesarean section. All were breast feeding, except one in the study group.

Mean duration of admission in the interventional group was significantly lower than controls. Likewise the mean decrease in bilirubin level after 24 hand 48 hof phototherapy were significantly lower than controls (Table 1).

None of the babies required phototherapy for rebound hyperbilirubinemia. None of the babies developed hypothermia or hyperthermia. None experienced significant weight loss while on phototherapy. None of the babies showed any detectable abnormality on neurological examination before discharge.

Discussion

Conventional treatment for severe unconjugated hyperbilirubinemia consists of phototherapy and exchange transfusion. Phototherapy however, has several known disadvantages while exchange transfusion is associated with significant morbidity. These harmful effects indicate the need to develop new methods. One alternative method is pharmacological.

Several pharmacological therapies such as metalloporhyrins, clofibrate, bile salts, laxatives and bilirubin oxidases have been used. (9, 10) Recently it has been shown that light emitting diode (LED) phototherapy is as efficacious as compact fluorescent tube (CFT) phototherapy for the treatment of nonhemolytic jaundice in healthy term and late preterm neonates(11).

CFT is still the gold standard and the method of choice in many neonatal units worldwide. Results show that the use of mirrors behind the bulbs in tunnel phototherapy units can safely increase the efficacy of phototherapy. We found MCTP more effective than simple phototherapy. The shorter duration of treatment means that more patients can be treated with fewer phototherapy units. Secondly, decreasing the duration of phototherapy may lead to a shorter length of hospitalization. This would also mean considerably less separation from the mother and less interruption of breast feeding.

Conclusion

Our results show that the use of mirrors behind the bulbs in tunnel phototherapy units can safely increase the efficacy of phototherapy.

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Table-1. Bilirubin level during 48 hr after intervention

	Bilirubin level before intervention	Duration of admission	Bilirubin difference in 24 hr	Bilirubin difference in48 hr
Intervention group	19.8±3.41	2.63 ± 0.67	6.48 ± 3.56	10.99 ± 3.93
Control group	18.57±3.16	2.97 ± 0.66	4.06 ± 3.56	8.74 ± 3.27
P value	P=0.10	P= 0.027	P= 0.005	P=0.036

**Main Power 220 v 2 a 50 Hz
Equipment Dimensions Lengh:70 cm Width:76cm High:116cm
-Weight 50kg - Lamp Bulbs Specifications PHILIPS TL20W/52 -
Radiation range 360
Other items Spare matters Optional items Serum Stand)

white reflecting curtains. Arch Dis Child Fetal Neonatal Ed 2006; 91: 439-4442
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